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SUPPLEMENT---VI.

REVIEWS.

Geology and Mineralogy considered with reference to Natural Theology. By the Rev. William Buckland, D.D., Canon of Christ Church, and Reader in Geology and Mineralogy in the University of Oxford. 2 vols. Pickering. London, 1836.

[*Continued from page* 18.]

When the science of geology first begun to be cultivated, and when it had disclosed the almost universal fact of innumerable bones and shells being enclosed in the various rocks and strata, constituting the exterior portion of the globe, various theories and hypotheses were devised to account for these phenomena. These theories, based on imperfect knowledge and preconceived ideas, have for the most part melted away before subsequent researches, and more accurate and more extended observations of the phenomena which they were intended to explain. In some cases, however, they have been so commonly received, and are so closely connected with our usual modes of thinking, that it is even yet necessary to demonstrate their fallacy; an observation which applies to that part of Dr. Buckland's work, which we have next to consider, and in which he treats of the "supposed cases of fossil human bones."

Among the few physical facts recorded by the inspired historians, one of the most striking, and to us, perhaps, the most interesting, is the great catastrophe by water, usually termed the "Mosaic Deluge." When this great event took place, we are informed, in the only narrative which records it, that the "fountains of the great deep were broken up," that "the windows of Heaven were opened," and that the "waters prevailed exceedingly upon the earth," so that "all the high hills that were under the whole heaven were covered." The whole human race, with the exception of a single family, is described as having perished, and all the inferior creation, excepting the few individuals preserved to propagate their species, are stated to have been involved in the same common and universal destruction.

Whether this catastrophe actually extended over the whole earth, and, as at a far more ancient geological period, the entire superficies of our globe was again encircled by the ocean, whether, literally, in the language of the poet—

——"Sea covered sea,
Sea without shore."

Or whether we are to make allowance for the grand and figurative language of all ancient, and especially of oriental, writings; and to consider the deluge as merely confined to that limited portion of the earth, which, we have reason to believe, was then inhabited by man, is a subject not discussed in the volumes before us, nor is it here our province to inquire; it is sufficient to observe that in the earlier days of geological research, or rather of geological *speculation*, the Mosaic deluge was very generally identified with those great revolutions of our planet, which have formed its entire stratified covering, enveloping therein the petrified remains of the inhabitants of our most ancient seas and shores. This idea was indeed, at a period of imperfect knowledge, so natural, that we cannot feel surprised at its having been once entertained; but, it need scarcely be observed, that it has long been added to the list of erroneous and exploded notions, which have prevailed at the dawn of every infant science.

At a period far more recent, and when geology had made such progress as clearly to establish the relative dates, as well as the nature and proximate causes of those revolutions, which had accumulated the materials of the stratified crust of the globe, and also to ascertain the fact of their being long anterior to the existence of the human race, it was commonly believed that all those great accumulations of the rounded and water-moved detritus of rocks, which are spread over so large a portion of the surface of the globe, and which often contain in vast profusion the almost unaltered bones of land animals, were referable to the Mosaic deluge. This opinion, indeed, carried so great an appearance of probability, that, although now greatly modified by subsequent and more exact researches, it was a few years ago very generally entertained by geologists, and found one of its most able advocates in Dr. Buckland himself, in his early and admirable work, the "Reliquiæ Diluvianæ," in which the subject of diluvial accumulations in plains and caverns was treated with a degree of elegance and originality, which at once ranked its author both as a geologist and naturalist of no ordinary merit.

During the long period therefore, reaching in fact almost to the present day, that it was customary to refer any extensive class of geological phenomena to the Mosaic deluge, it was very naturally expected also, that *fossil human bones* might be found, as these were in every respect as likely to have been preserved, as those of the various animals found buried in such abundance in the supposed diluvial ruin. This expectation did appear, indeed, to some extent, to have been realised, many bones and portions of skeletons supposed to be human, were found in certain quarries on the continent, and the celebrated "homo diluvii testis," of a German naturalist, was for a long time considered to afford decisive evidence of the fact. On examining, however, these supposed relics of our species, the profound and accurate knowledge of Cuvier enabled him at once to pronounce with certainty, that not one of them had ever formed part of a human frame, and that, notwithstanding their supposed resemblance, they were in reality the bones of inferior animals.

At a comparatively recent period, however, it is certain that human bones have been discovered, under circumstances very analogous to those of fossil animals, and to determine the date of these has been a problem of no inconsiderable interest. The most remarkable cases of this kind which have occurred, are the celebrated fossil human skeletons of Guadaloupe, one of which is preserved in the British Museum. Other instances of human bones being found in situations analogous to those of extinct and fossil animals, have occurred in France and some other parts of the continent. Here human relics have been found in caves, sometimes buried in superficial deposits, containing also the undoubted fossil bones of extinct animals. In some instances, even rude tools and works of art have been discovered buried in the same mass. These phenomena certainly, at first sight, countenancing the old and favourite idea before mentioned, have been examined with all the attention they deserve; and the result of their examination has been, completely to negative the supposition of their being contemporaneous with the fossil bones of animals, or co-existent with any but the most recent class of geological changes. As regards the human skeletons of Guadaloupe, which are very remarkable, Cuvier states, that the bones still contain "a portion of their *animal matter*, and the whole of their phosphate of lime;" thus affording a decisive proof of their modern origin and scarcely altered texture. As regards the nature and antiquity of the rock in which they are imbedded, it appears that it is merely a species of *tufa*, "formed and daily increased by very small particles of shells and corals, which the sea washes away from the rocks, the whole mass of which coheres very firmly in those parts which are most frequently left dry." As a further proof of the recent origin of this rock, which is, indeed, at the present moment, gradually forming, it may be stated, that it contains imbedded the same shells as now live in the adjoining sea, and also land shells still existing on the neighbouring coast. The result of this examination is, therefore, entirely to strip the Guadaloupe skeletons of any fancied antiquity, or of any supposed connexion with the ancient revolutions of the globe; and their real origin is, in all probability, to be attributed to a battle between two of the native tribes, which, according to tradition, took place on the spot, a century or two ago. These human skeletons, therefore, the most remarkable that have been discovered, may, no doubt, be referred to the accidental circumstance of some of the bodies of the slain becoming enveloped in the calcareous sand of the adjoining beach, or very possibly to their having been buried on the spot.

On examining the cases of human bones discovered in caverns, mixed with those of extinct animals, and which present but little claim to geological antiquity, Dr. Buckland very justly observes, that they "may be explained by the common practice of mankind, in all ages, to bury their dead in such convenient repositories." He further remarks, that the soil having been repeatedly broken up for such purposes, the admixture of human and fossil bones may have been thus produced by merely accidental causes, and therefore affords no proof whatever of contemporaneous origin.

As we have now arrived at that part of Dr. Buckland's work (and it is by far the longest and most important portion) which is devoted to the "history of fossil organic remains," we have been thus minute on all that relates to supposed cases of fossil human bones, endeavouring to render this subject even more distinct and more prominent than Dr. Buckland has done. Our reason for this has been, that we have now to enter on a scene in which *Man* was no actor, and where we are presented with the extraordinary, and to some, perhaps, almost incredible spectacle, of an earth tenanted solely by the inferior classes of the creation, often of forms strange and uncouth, and of dimensions vast and extraordinary. We are entering on a period of the earth's history, when the fertile plains now crowded with populous cities, were tenanted only by the elephant, the rhinoceros, the hippopotemus, and their allied races of pachydermata—when the existing creeks and bays, instead of affording harbours for shipping, and being encircled by ports resounding with the din of commerce, were alone inhabited by gigantic crocodiles and saurians, and when the only sail spread on the vast expanse of ocean, was that of the little nautilus—a period when the primeval forests waved in undisturbed luxuriance over the newborn lands, and "no feller came up against them."

To have made us familiarly acquainted with this far-remote and marvellous state of our planet, is one of the greatest boasts of modern science; and not only are we shown the forms of the animals which then inhabited it, but we are enabled also to see their very habits and modes of existence. Among the curious facts which have thus been ascertained with a certainty amounting to demonstration, one of those which, perhaps, in a philosophical point of view, is most interesting and remarkable, is, the number, the variety, and the formidable structure of the extinct races of *carnivorous* animals which prevailed at very remote geological epochs.

To reconcile with the attributes of the Deity the existence of numerous and powerful races of animals provided by nature with the most skilful organs of destruction, and formed only to prey upon the more weak and defenceless portion of the creation, more especially when we see this principle carried back almost to the remotest period of animal existence, appears certainly a task of some difficulty. As, however, the structure of extinct *carnivora* occupies a considerable space in the work before us, Dr. Buckland has very properly prefaced it by an examination of the tendency of this great and universal law of animal existence, which decrees that every creature should in time become the food of another. The chapter devoted to this subject is an admirable specimen of philosophical reasoning, employed in the investigation of a curious and apparently contradictory dispensation of Providence.

The following extract will show the view which Dr. Buckland takes of this curious and interesting subject:—

"The law of universal mortality being the established condition on which it has pleased the Creator to give being to every creature upon earth, it is a dispensation of kindness to make the end of life to each individual as easy as possible. The most easy death is, proverbially, that which is the least expected; and though, for moral reasons, peculiar to our own species, we deprecate the *sudden* termination of our mortal life; yet, in the case of every inferior animal, such a termination of existence is obviously the most desirable. The pains of sickness, and decrepitude of age, are the usual precursors of death, resulting from gradual decay: these, in the human race alone, are susceptible of alleviation from internal sources of hope and consolation; and give exercise to some of the highest charities, and most tender sympathies of humanity. But, throughout the whole creation of inferior animals, no such sympathies exist; there is no affection or regard for the feeble and aged; no alleviating care to relieve the sick; and the extension of life through lingering stages of decay and of old age, would to each individual be a scene of protracted misery. Under such a system, the natural world would present a mass of daily suffering, bearing a large proportion to the total amount of animal enjoyment. By the existing dispensations of sudden destruction and rapid succession, the feeble and disabled are speedily relieved from suffering, and the world is at all times crowded with myriads of sentient and happy beings; and though to many individuals their allotted share of life be often short, it is usually a period of uninterrupted gratification; whilst the momentary pain of sudden and unexpected death is an evil infinitely small, in comparison with the enjoyments of which it is the termination.

"The inhabitants of the earth have ever been divided into two great classes, the one herbivorous, the other carnivorous; and though the existence of the latter may, at first sight, seem calculated to increase the amount of animal pain; yet, when considered in its full extent, it will be found materially to diminish it.

"To the mind which looks not to general results in the economy of Nature, the earth may seem to present a scene of perpetual warfare, and incessant carnage: but the more enlarged view, while it regards individuals in their conjoint relations to the general benefit of their own species, and that of other species with which they are associated in the great family of Nature, resolves each apparent case of individual evil into an example of subserviency to universal good.

"Under the existing system, not only is the aggregate amount of animal enjoyment much increased, by adding to the stock of life all the races which are carnivorous, but these are also highly beneficial even to the herbivorous races, that are subject to their dominion.

"Besides the desirable relief of speedy death on the approach of debility or prey, as they control their excessive increase, by the destruction of many individuals in youth and health. Without this salutary check, each species would soon multiply to an extent, exceeding in a fatal degree their supply of food, and the whole class of herbivora would ever be so nearly on the verge of starvation, that multitudes would daily be consigned to lingering and painful death by famine. All these evils are superseded by the establishment of a controlling Power in the carnivora; by their agency the numbers of each species are maintained in due proportion to one another—the sick, the lame, the aged, and the supernumeraries, are consigned to speedy death; and while each suffering individual is soon relieved from pain, it contributes its enfeebled carcase to the support of its carnivorous benefactor, and leaves more room for the comfortable existence of the healthy survivors of its own species.

"The same 'police of Nature,' which is thus beneficial to the great family of the inhabitants of the land, is established with equal advantage among the tenants of the sea. Of these also, there is one large division that lives on vegetables, and supplies the basis of food to the other division that is carnivorous. Here again we see, that in the absence of carnivora, the uncontrolled herbivora would multiply indefinitely, until the lack of food brought them also to the verge of starvation; and the sea would be crowded with creatures under the endurance of universal pain from hunger, while death by famine would be the termination of ill-fed and miserable lives.

"The appointment of death by the agency of carnivora, as the ordinary termination of animal existence, appears therefore in its main results to be a dispensation of benevolence; it deducts much from the aggregate amount of the pain of universal death; it abridges, and almost annihilates, throughout the brute creation, the misery of disease, and accidental injuries, and lingering decay; and imposes such salutary restraint upon excessive increase of numbers, that the supply of food maintains perpetually a due ratio to the demand. The result is, that the surface of the land and depths of the waters are ever crowded with myriads of animated beings, the pleasures of whose life are co-extensive with its duration; and which, throughout the little day of existence that is allotted to them, fulfil with joy the functions for which they were created. Life to each individual is a scene of continued feasting, in a region of plenty; and when unexpected death arrests its course, it repays with small interest the large debt, which it has contracted to the common fund of animal nutrition, from whence the materials of its body have been derived. Thus the great drama of universal life is perpetually sustained; and though the individual actors undergo continual change, the same parts are ever filled by another and another generation; renewing the face of the earth, and the bosom of the deep, with endless successions of life and happiness."

The body of the work at which we have now arrived, is entirely occupied by an examination of the structure and habits of the principal extinct races of animals, whose mineralised remains are now imbedded in the various strata composing the exterior of the globe, and are thus preserved and presented to our examination.

To this part of the treatise it is, from the nature of the subject, quite impossible to do justice, as the argument depends on a great variety of minute anatomical details, proving the peculiar habits of the animals under consideration, and the perfect adaptation of their structure to perform the various functions required by them. It is sufficient to observe, that from the rich stores of inexhaustible contrivances, which are presented to us by nature in all her works, whether in the animated beings now breathing before our eyes, and co-existent with ourselves, or in those which were entombed in the solid framework of the globe, perhaps thousands, or tens of thousands of years before the human race existed, Dr. Buckland has selected many of the most striking and remarkable, of those relating to the various forms of fossil organization. This part of the subject is admirably illustrated by the numerous and beautiful plates which occupy the second volume, and which place before the eye in a palpable point of view, forms and details which could only in this manner be rendered intelligible to those not versed in comparative anatomy, and which, without such illustration, it is hopeless for us to attempt.

In order to show the nature of the argument pursued in this part of the work, we shall proceed to extract some portion of the description of the *megatherium*, one of the most strange and anomalous beings of the ancient world. The following passages in reference to fossil zoology, explain the general principles on which this branch of science is founded:—

"As it will be quite impossible, in the present treatise, to give particular descriptions of the structure, even of a few of the fossil Mammalia, which have been, as it were, restored again to life by the genius and industry of Cuvier; I shall endeavour to illustrate, by the details of a single species, the method of analytical investigation, that has been applied by that great philosopher to the anatomy both of fossil and recent animals.

"The result of his researches, as recorded in the 'Ossemens Fossiles,' has been to show that all fossil quadrupeds, however differing in generic or specific details, are uniformly constructed on the same general plan, and systematic basis of organization as living species; and that throughout the various adaptations of a common type to peculiar functions, under different conditions of the earth, there prevails such universal conformity of design, that we cannot rise from the perusal of these inestimable volumes, without a strong conviction of the agency of one vast and mighty Intelligence, ever directing the entire fabric, both of past and present systems of creation.

"Nothing can exceed the accuracy of the severe and logical demonstrations, that fill these volumes with proofs of wise design, in the constant relation of the parts of animals to one another, and to the general functions of the whole body. Nothing can surpass the perfection of his reasoning, in pointing out the beautiful contrivances, which are provided in almost endless variety, to fit every living creature to its own peculiar state and mode of life. His illustration of the curious conditions, and concurrent compensations that are found in the living elephants, apply equally to the extinct fossil species of the same genus; and similar exemplifications may be extended from the living to the extinct species of other genera, e. g. rhinoceros, hippopotamus, horse, ox, deer, tiger, hyena, wolf, &c., that are usually associated with the elephant in a fossil state."

In reference to the peculiar structure and functions of the *megatherium*, Dr. Buckland then proceeds—

"The animal I shall select for my present purpose is that most extraordinary fossil creature, the megatherium, an animal, in some parts of its organization, nearly allied to the sloth, and, like the sloth, presenting an apparent monstrosity of external form, accompanied by many strange peculiarities of internal structure, which have hitherto been but little understood.

"The sloths have afforded a remarkable exception to the conclusions which naturalists have usually drawn, from their study of the organic structure and mechanism of other animals. The adaptation of each part of the body of the elephant to produce extraordinary strength, and of every member of the deer and antelope to give agility and speed, are too obvious to have escaped the attention of any scientific observer; but it has been the constant practice of naturalists to follow Buffon in misrepresenting the sloths as the most imperfectly constructed among all the members of the animal kingdom, as creatures incapable of enjoyment, and formed only for misery.

"The sloth does, indeed, afford the greatest deviations from the ordinary structure of living quadrupeds; and these have been erroneously considered as imperfections in its organization, without any compensating advantage. I have elsewhere attempted to show that these anomalous conditions are so far from being defects, or sources of inconvenience in the sloth, that they afford striking illustrations of the varied contrivances, whereby the structure of every creature is harmoniously adapted to the state in which it was destined to live. The peculiarities of the sloth, that render its movements so awkward on the earth, are fitted with much advantage to its destined office of living entirely upon trees, and feeding upon their leaves: so also, if we consider the megatherium with a view to its province of digging and feeding upon roots, we shall, in this habit, discover the explanation of its unusual structure, and apparently incongruous proportions; and find, in every organ, a relation of obvious convenience, and of adaptation to the office it had to discharge.

It will be my present object to enter into such a minute investigation of some of the more remarkable parts of this animal, viewing them with a constant reference to a peculiar mode of life, as may lead to the recognition of a

parently the most monstrous, and seemed to present the most ill-assorted proportions that occur throughout the entire range of the animal kingdom.

"We have here before us a gigantic quadruped, which at first sight appears not only ill-proportioned as a whole, but whose members also seem incongruous and clumsy, if considered with a view to the functions and corresponding limbs of ordinary quadrupeds: let us only examine them with the aid of that clue, which is our best and essential guide in every investigation of the mechanism of the animal frame; let us first infer from the total composition and capabilities of the machinery what was the general nature of the work it was destined to perform; and from the character of the most important parts, namely, the feet and teeth, make ourselves acquainted with the food these organs were adapted to procure and masticate, and we shall find every other member of the body acting in harmonious subordination to this chief purpose in the animal economy,

"In the case of ordinary animals, the passage from one form to another is so gradual, and the functions of one species receive such ample and obvious illustrations from those of the species adjacent to it, that we are rarely at a loss to see the final cause of almost every arrangement that is presented to the anatomist. This is more especially the case with respect to the skeleton, which forms the foundation of all the other mechanisms within the body, and is of the highest importance in the history of fossil animals, of which we rarely find any other remains besides the bones, and teeth, and the scaly or osseous integuments. I select the megatherium, because it affords an example of most extraordinary deviations, and of egregious apparent monstrocity; viz. the case of a gigantic animal exceeding the largest rhinoceros in bulk, and to which the nearest approximations that occur in the living world, are found in the not less anomalous genera of sloth, armadillo, and chlamyphorus: the former adapted to the peculiar habit of residing upon trees; the two latter constructed with unusual adaptations to the habit of burrowing in search of their food, and shelter in sand; and all limited in their geographical distribution, nearly to the same regions of America that were once the residence of the megatherium.

"I shall not here enter on the unsettled questions as to the precise age of the deposits in which the megatherium is found, or the causes by which it has been extirpated; my object is to show that the apparent incongruities of all its parts are in reality systems of wise and well-contrived adaptation to a peculiar mode of life. I proceed, therefore, to consider, in the order in which they are described by Cuvier, the most important organs of the megatherium, beginning with the head, and from thence advancing to the trunk and extremities."

Passing entirely over various anatomical details respecting the structure of the animal, we come to the description of the bony armour with which it appears to have been encased, and of which Dr. Buckland gives the following account:—

"Another remarkable character of the megatherium, in which it approaches most nearly to the armadillo and chlamyphorus, consists, in its hide having probably been covered with a bony coat of armour; varying from three-fourths of an inch, to an inch and half in thickness, and resembling the armour which covers these living inhabitants, of the same warm and sandy regions of South America.

"A covering of such enormous weight, would have been consistent with the general structure of the megatherium; its columnar hind legs and colossal tail were calculated to give it due support; and the strength of the loins and ribs, being very much greater than in the elephant, seems to have been necessary for carrying so ponderous a cuirass as that which we suppose to have covered the body.

"It remains to consider, of what use this cuirass could have been to the gigantic animal on which it probably was placed. As the locomotive organs of the megatherium indicate very slow power of progression, the weight of a cuirass would have afforded little impediment to such tardy movements; its use was probably defensive, not only against the tusks and claws of beasts of prey, but also against the myriads of insects that usually swarm in such climates as those wherein its bones are found; and to which an animal that obtained its food by digging beneath a broiling sun would be in a peculiar degree exposed. We may also conjecture it to have had a further use in the protection afforded by it to the back, and upper parts of the body; not only against the sun and rain, but against the accumulations of sand and dust, that might otherwise have produced irritation and disease."

The following are the concluding passages in which the proofs of intelligence and design manifested in the osseous framework of this extraordinary animal, are briefly summed up:—

"We have now examined in detail the skeleton of an extinct quadruped of enormous magnitude; every bone of which presents peculiarities, that at first sight appear imperfectly contrived, but which become intelligible when viewed in their relations to one another, and to the functions of the animal in which they occur.

"The size of the megatherium exceeds that of the existing edentata, to which it is most nearly allied, in a greater degree than any other fossil animal exceeds its nearest living congeners. With the head and shoulders of a sloth, it combined in its legs and feet, and admixture of the characters of the ant-eater, the armadillo, and the chlamyphorus; it probably also still further resembled the armadillo and chlamyphorus, in being cased with a bony coat of armour. Its haunches were more than five feet wide, and its body twelve feet long and eight feet high; its feet were a yard in length, and terminated by most gigantic claws; its tail was probably clad in armour, and much larger than the tail of any other beast, among extinct or living terrestrial mammalia. Thus heavily constructed, and ponderously accoutred, it could neither run, nor leap, nor climb, nor burrow under the ground, and in all its movements must have been necessarily slow; but what need of rapid locomotion to an animal, whose occupation of digging roots for food was almost stationary? and what need of speed for flight from foes, to a creature whose giant carcase was encased in an impenetrable cuirass, and who by a single pat of his paw, or lash of his tail, could in an instant have demolished the cougnar or the crocodile? Secure within the panoply of his bony armour, where was the enemy that would dare encounter this leviathan of the pampas? or, in what more powerful creature can we find the cause that has effected the extirpation of his race?

"His entire frame was an apparatus of colossal mechanism, adapted exactly to the work it had to do; strong and ponderous, in proportion as this work was heavy, and calculated to be the vehicle of life and enjoyment to a gigantic race of quadrupeds; which, though they have ceased to be counted among the living inhabitants of our planet, have, in their fossil bones, left behind them imperishable monuments of the consummate skill with which they were constructed. Each limb, and fragment of a limb, forming coördinate parts of a well-adjusted and perfect whole; and through all their deviations from the form and proportion of the limbs of other quadrupeds, affording fresh proofs of the infinitely varied and inexhaustible contrivances of Creative Wisdom."

From the chapters devoted to the consideration of the numerous and extinct races of *saurians*, we extract the following introductory remarks on one of the most remarkable species—the *ichthyosaurus*:—

"Nearly at the head of the surprising discoveries which have been made relating to the family of saurians, we may rank the remains of many extraordinary species, which inhabited the sea; and which present almost incredible combinations of form and structure; adapting them for modes of life, that do not occur among living reptiles. These remains are most abundant throughout the lias and oolite formations of the secondary series. In these deposits we find not only animals allied to crocodiles, and nearly approaching to the gavial of the Ganges; but also still more numerous gigantic lizards, that inhabited the then existing seas and estuaries.

"Some of the most remarkable of these reptiles have been arranged under the genus ichthyosaurus (or fish lizard), in consequence of the partial resemblance of their vertebræ to those of fishes. If we examine these creatures with a view to their capabilities of locomotion, and the means of offence and defence, which their extraordinary structure afforded to them; we shall find combinations of form and mechanical contrivances, which are now dispersed through various classes and orders of existing animals, but are no longer united in the same genus. Thus, in the same individual, the snout of a porpoise is combined with the teeth of a crocodile, the head of a lizard with the vertebræ of a fish, and the sternum of an ornithorhynchus with the paddles of a whale. The general outline of an ichthyosaurus must have most nearly resembled the modern porpoise and grampus. It had four broad feet or paddles, and terminated behind in a long and powerful tail. Some of the largest of these reptiles must have exceeded thirty feet in length.

"There are seven or eight known species of the genus ichthyosaurus, all agreeing with one another in the general principles of their construction, and the possession of those peculiar organs, in which I shall endeavour to point out the presence of mechanism and contrivance, adapted to their habits and state of life."

Passing over many details of structure, we find the following passages containing many general and interesting remarks on the *saurian* family:—

"In the form of its extremities, the ichthyosaurus deviates from the lizards, and approaches the whales. A large animal, moving rapidly through the sea, and breathing air, must have required great modification of the fore-leg and foot of the lizard, to fit it for such cetaceous habits. The extremities were to be converted into fins instead of feet, and as such we shall find them to combine even a still greater union of elasticity with strength, than is presented by the fin or paddle of the whale. The polygonal bones vary in number in different species, in some exceeding one hundred; they differ also in form from the phalanges both of lizards and whales; and de-rive, from their increase of number, and change of dimensions, an increase of elasticity and power. The arm and hand thus converted into an elastic oar or paddle, when covered with skin, must have much resembled externally the undivided paddle of a porpoise or whale. The position also of the paddles on the anterior part of the body was nearly the same; to these were superadded posterior extremities, or hind fins, which are wanting in the cetacea, and which possibly make compensation for the absence of their flat horizontal tail: these hind paddles in the ichthyosaurus are nearly by one half smaller than the anterior paddles.

"Mr. Conybeare remarks, with his usual acumen, that 'the reasons of this variation from the proportions of the posterior extremities of quadrupeds in general, are the same which lead to a similar diminution of the analogous parts in seals, and their total disappearance in the cetacea, namely, the necessity of placing the centre of the organs of motion, when acting laterally, before the centre of gravity. For the same reason, the wings of birds are placed in the fore part of their body, and the centre of the moving forces given to ships by their sails, and to steam-boats by their paddles, is similarly placed. The great organ of motion in fishes, the tail, is indeed posteriorly placed, but this by its mode of action generates a *vis a tergo*, which impels the animal straight forwards, and does not therefore operate under the same conditions with organs laterally applied.'—G. T. V. 5, p. 579.

"I shall conclude this detailed review of the peculiarities of one of the most curious, as well as the most ancient, among the many genera of extinct reptiles presented to us by geology, with a few remarks on the final causes of those deviations from the normal structure of its proper type, the lizard; under which the ichthyosaurus combines in itself the additional characters of the fish, the whale, and ornithorhynchus. As the form of vertebræ by which it is associated with the class of fishes, seems to have been introduced for the purpose of giving rapid motion in the water to a lizard inhabiting the element of fishes; so the further adoption of a structure in the legs, resembling the paddles of a whale, was superadded in order to convert these extremities into powerful fins. The still further addition of a furcula and clavicles, like those of the ornithorhynchus, offers a third and not less striking example of selection of contrivances, to enable animals of one class to live in the element of another class.

"If the laws of co-existence are less rigidly maintained in the ichthyosaurus, than in other extinct creatures which we discover amid the wreck of former creations, still these deviations are so far from being fortuitous, or evidencing imperfection; that they present examples of perfect appointment and judicious choice, pervading and regulating even the most apparently anomalous aberrations.

"Having the vertebræ of a fish, as instruments of rapid progression; and the paddles of a whale, and sternum of an ornithorhynchus, as instruments of elevation and depression; the reptile ichthyosaurus united in itself a combination of mechanical contrivances, which are now distributed among three distinct classes of the animal kingdom. If, for the purpose of producing vertical movements in the water, the sternum of the living ornithorhynchus assumes forms and combinations that occur but in one other genus of mammalia, they are the same that co-existed in the sternum of the ichthyosaurus of the ancient world; and thus, at points of time, separated from each other by the intervention of incalculable ages, we find an identity of objects effected by instruments so similar, as to leave no doubt of the unity of the design in which they all originated.

"It was a necessary and peculiar function in the economy of the fish-like lizard of the ancient seas, to ascend continually to the surface of the water in order to breathe air, and to descend again in search of food; it is a no less peculiar function in the duck-billed ornithorhynchus of our own days, to perform a series of similar movements in the lakes and rivers of New Holland.

"The introduction to these animals, of such aberrations from the type of their respective orders, to accommodate deviations from the usual habits of these orders, exhibits an union of compensative contrivances, so similar in their relations, so identical in their objects, and so perfect in the adaptation of each subordinate part, to the harmony and perfection of the whole, that we cannot but recognise throughout them all the workings of one and the same eternal principle of wisdom and intelligence, presiding from first to last over the total fabric of creation."

On the intestinal structure and carnivorous habits of *saurians*, the following passages convey much curious information:—

"It is impossible to have seen the large apparatus of teeth, and strength of jaws, which we have been examining in the ichthyossuri, without concluding that animals furnished with such powerful instruments of destruction must have used them freely in restraining the excessive population of the ancient seas. This inference has been fully confirmed by the recent discovery within their skeletons of the half-digested remains of fishes and reptiles, which they had devoured, and by the further discovery of coprolites, i. e. of fœcal remains in a state of petrifaction, dispersed through the same strata in which these skeletons are buried. The state of preservation of these very curious petrified bodies is often so perfect, as to indicate not only the food of the animals from which they were derived, but also the dimensions, form, and structure of their stomach, and intestinal canal.

"On the shore at Lyme Regis, these coprolites are so abundant, that they lie in some parts of the lias like potatoes scattered in the ground; still more common are they in the lias of the Estuary of the Severn, where they are similarly disposed in strata of many miles in extent, and mixed so abundantly with teeth and rolled fragments of the bones of reptiles and fishes, as to show that this region having been the bottom of an ancient sea, was for a long period the receptacle of the bones and fœcal remains of its inhabitants. The occurrence of coprolites is not, however, peculiar to the places just mentioned, they are found in greater or less abundance throughout the lias of England; they occur also in strata, of all ages that contain the remains of carnivorous reptiles, and have been recognised in many and distant regions both of Europe and America.

"The certainty of the origin of these coprolites is established by their frequent presence in the abdominal region of fossil skeletons of ichthyosauri found in the lias of Lyme Regis. The coprolitic matter loaded with fish-scales, within the ribs of these and similar specimens, is identical in appearance and chemical composition with the insulated coprolites that occur in the same strata with the skeletons. The preservation of such fœcal matter, and its conversion to the state of stone, result from the imperishable nature of the phosphate of lime, of which both bones and the products of digested bones are equally composed.

"The skeleton of another ichthyosaurus in the Oxford Museum, from the lias at Lyme Regis, shows a large mass of fish scales, chiefly referrable to the pholidophorus limbatus, intermixed with coprolite throughout the entire region of the ribs; this mass is overlaid by many ribs, and although, in some degree perhaps, extended by pressure, it shows that the length of the stomach was nearly co-extensive with the trunk.

"Among living voracious reptiles we have examples of stomachs equally capacious; we know that whole human bodies have been found within the stomachs of large crocodiles; we know also, from the form of their teeth, that the ichthyosauri, like the crocodiles, must have gorged their prey entire; and when we find, imbedded in coprolites derived from the larger ichthyosauri, bones of smaller ichthyosauri, of such dimensions, that the individuals from which they were derived must have measured several feet in length; we infer that the stomach of these animals formed a pouch, or sac, of proportionate size, extending through nearly the entire cavity of the body, and of capacity duly proportioned to the jaws and teeth with which it co-operated."

Having extracted some of the passages relative to the *megatherium*, one of the most huge and extraordinary inhabitants of the ancient earth, and also those describing the *ichthyosaurus*, one of the most anomalous inhabitants of the ancient waters, we cannot pass without notice the *pterodactyle*, whose strange and monstrous form rendered it in the air, a fit companion for the uncouth beings maintained at that period by the earth and sea:—

"Among the most remarkable disclosures made by the researches of geology, we may rank the flying reptiles, which have been ranged by Cuvier under the genus pterodactyle; a genus presenting more singular combinations of form than we find in any other creatures yet discovered amid the ruins of the ancient earth.

"The structure of these animals is so exceedingly anomalous, that the first discovered pterodactyle was considered by one naturalist to be a bird, by another as a species of bat, and by a third as a flying reptile.

"This extraordinary discordance of opinion respecting a creature whose skeleton was almost entire, arose from the presence of characters apparently belonging to each of the three classes to which it was referred. The form of its head, and length of neck, resembling that of birds, its wings approaching to the proportion and form of those of bats, and the body and tail approximating to those of ordinary mammalia. These characters, connected with a small skull, as is usual among reptiles, and a beak furnished with not less than sixty pointed teeth, presented a combination of apparent anomalies which it was reserved for the genius of Cuvier to reconcile. In his hands, this apparently monstrous production of the ancient world, has been converted into one of the most beautiful examples yet afforded by comparative anatomy of the harmony that pervades all nature, in the adaptation of the same parts of the animal frame to infinitely varied conditions of existence.

"In the case of the pterodactyle we have an extinct genus of the order saurians, in the class of reptiles (a class that now moves only on land or in the water), adapted by a peculiarity of structure to fly in the air. It will be interesting to see how the anterior extremity, which in the fore-leg of the modern lizard and crocodiles is an organ of locomotion on land, became converted into a membraniferous wing; and how far the other parts of the body are modified so as to fit the entire animal machine for the functions of flight. The details of this inquiry will afford such striking examples of numerical agreement in the component bones of every limb, with those in the corresponding limbs of living lizards, and are at the same time so illustrative of contrivances for the adjustment of the same organ to effect different ends, that I shall select for examination a few points from the long and beautiful analysis which Cuvier has given of the structure of this animal.

"The pterodactyles are ranked by Cuvier among the most extraordinary of all the extinct animals that have come under his consideration; and such as, if we saw them restored to life, would appear most strange, and most unlike to any thing that exists in the present world.—'Ce sont incontestablement de tous les êtres dont ce livre nous révele l'ancienne existence, les plus extraordinaires, et ceux qui, si on les voyait vivans, paroîtroient les plus étrangers à tout la nature actuelle.' (Cuv. Oss. Foss. vol. v. Pt. 11, p. 379.

"We are already acquainted with eight specimens of this genus, varying from the size of a snipe to that of a cormorant.

"In external form these animals somewhat resemble our modern bats and vampires: most of them had the nose elongated, like the snout of a crocodile, and armed with conical teeth. Their eyes were of enormous size, apparently enabling them to fly by night. From their wings projected fingers, terminated by long hooks, like the curved claw on the thumb of the bat. These must have formed a powerful paw, wherewith the animal was enabled to creep, or climb, or suspend itself from trees.

"It is probable also that the pterodactyles had the power of swimming, which is so common in reptiles, and which is now possessed by the pteropus pselaphon, or vampire bat of the island of Bonin. (See Zool. Journ. No. 16, p. 458.) 'Thus, like Milton's fiend, all qualified for all services and all elements, the creature was a fit companion for the kindred reptiles that swarmed in the seas, or crawled on the shores of a turbulent planet.

> 'The fiend,
> O'er bog, or steep, through strait, rough, dense or rare,
> With head, hands, wings, or feet, pursues his way,
> And swims, or sinks, or wades, or creeps, or flies.'
>
> *Paradise Lost*, Book II. line 947.

With flocks of such-like creatures flying in the air, and shoals of no less monstrous ichthyosauri and plesiosauri swarming in the ocean, and gigantic crocodiles and tortoises crawling on the shores of the primeval lakes and rivers, air, sea, and land, must have been strangely tenanted in these early periods of our infant world.'"

One of the most extraordinary and stupendous of the ancient reptiles, is the *iguanodon*, whose existence was only made known to us a few years since, through the indefatigable researches of Mr. Mantell. This reptile appears to have attained the great length of seventy feet, and to have been herbivorous, resembling, indeed, in every thing but its enormous dimensions, the modern *iguana* of tropical America. The following passages give a general description of this reptile:—

"As the reptiles hitherto considered appear from their teeth to have been carnivorous, so we find extinct species of the same great family, that assumed the character and office of herbivora. For our knowledge of this genus, we are indebted to the scientific researches of Mr. Mantell. This indefatigable historian of the Wealden fresh-water formation, has not only found the remains of the plesiosaurus, megalosaurus, hylæosaurus, and several species of crocodiles and tortoises in these deposits, of a period intermediate between the oolitic and cretaceous series, but has also discovered in Tilgate Forest the remains of the iguanodon, a reptile much more gigantic than the megalosaurus, and which, from the character of its teeth, appears to have been herbivorous. The teeth of the iguanodon are so precisely similar, in the principles of their construction, to the teeth of the modern iguana, as to leave no doubt of the near connexion of this most gigantic extinct reptile with the iguanas of our own time. When we consider that the largest living iguana rarely exceeds five feet in length, whilst the congenerous fossil animal must have been nearly twelve times as long, we cannot but be impressed by the discovery of a resemblance, amounting almost to identity, between such characteristic organs as the teeth, in one of the most enormous among the extinct reptiles of the fossil world, and those of a genus whose largest species is comparatively so diminutive. According to Cuvier, the common iguana inhabits all the warm regions of America: it lives chiefly upon trees, eating fruits, and seeds, and leaves. The female occasionally visits the water, for the purpose of laying in the sand its eggs, which are about the size of those of a pigeon.

"As the modern iguana is found only in the warmest regions of the present earth, we may reasonably infer that a similar, if not a still warmer climate, prevailed at the time when so huge a lizard as the iguanodon inhabited what are now the temperate regions of the southern coasts of England. We know from the fragment of a femur, in the collection of Mr. Mantell, that the thigh-bone of this reptile much exceeded in bulk that of the largest elephant: this fragment presents a circumference of twenty-two inches in its smallest part, and the entire length must have been between four and five feet. Comparing the proportions of this monstrous bone with those of the fossil teeth with which it is associated, it appears that they bear to one another nearly the same ratio that the femur of the iguana bears to the similarly constructed and peculiar teeth of that animal."

The important subject of fossil fishes is considered at some length; we extract the following passages:—

"The history of fossil fishes is the branch of paleontology which has hitherto received least attention, in consequence of the imperfect state of our knowledge of existing fishes. The inaccessible recesses of the waters they inhabit, renders the study of their nature and habits much more difficult than that of terrestrial animals. The arrangement of this large and important class of vertebrata was the last great work undertaken by Cuvier, not long before his lamented death, and nearly eight thousand species of living fishes had come under his observation. The full development of their history and numbers, and of the functions they discharge in the economy of nature, he has left to his able successors.

"The fact of the formation of so large a portion of the surface of the earth beneath the water, would lead us to expect traces of the former existence of fishes, wherever we have the remains of aquatic mollusca, articulata, and radiata. Although a few remarkable places have long been celebrated as the repositories of fossil fishes, even of these there are some, whose geological relations have scarcely yet been ascertained, while the nature of their fishes remains in still greater obscurity.

"The task of arranging all this disorder has at length been undertaken by an individual, to whose hands Cuvier at once consigned the materials he had himself collected for this important work. The able researches of Professor Agassiz have already extended the number of fossil fishes to 200 genera, and more than 850 species. The results of his inquiry throw a new and most important light on the state of the earth, during each of the great periods into which its past history has been divided. The study of fossil ichthyology is therefore of peculiar importance to the geologist, as it enables him to follow an entire class of animals, of so high a division as the vertebrate, through the whole series of geological formations; and to institute comparisons between their various conditions during successive periods of the earth's formation, such as Cuvier could carry only to a much more limited extent in the classes of reptiles, birds, and mammifers, for want of adequate materials.

"The system upon which M. Agassiz has established his classification of recent fishes is in a peculiar degree applicable to fossil fishes, being founded on the character of the external coverings, or scales. This character is so sure and constant, that the preservation, even of a single scale, will often announce the genus and even the species of the animal from which it was derived; just as certain feathers announce to a skilful ornithologist the genus or species of a bird. It follows still further, that as the nature of their outward covering indicates the relations of all animals to the external world, we derive from their scales certain indications of the relations of fishes; the scales forming a kind of external skeleton, analogous to the crustaceous or horny coverings of insects, to the feathers of birds, and the fur of quadrupeds, which shows more directly than the internal bones, their adaptation to the medium in which they lived.

"A further advantage arises from the fact that the enamelled condition of the scales of most fishes, which existed during the earlier geological epochs, rendered them much less destructible than their internal skeleton; and cases frequently occur where the entire scales and figure of the fish are perfectly preserved, whilst the bones within these scales have altogether disappeared; the enamel of the scales being less soluble than the more calcareous material of the bone.

"It must be obvious that another and most important branch of natural history is enlisted in aid of geology, as soon as the study of the character of fossil fishes has been established on any footing, which admits of such general application as the system now proposed. We introduce an additional element into geological calculations; we bring an engine of great power, hitherto unapplied, to bear on the field of our inquiry, and seem almost to add a new sense to our powers of geological perception. The general result is, that fossil fishes approximate nearest to existing genera and species, in the most recent tertiary deposits, and differ from them most widely in strata whose antiquity is the highest; and that strata of intermediate age are marked by intermediate changes of ichthyological condition.

"It appears still further, that all the great changes in the character of fossil fishes take place simultaneously with the most important alterations in the other classes of fossil animals, and in fossil vegetables; and also in the mineral condition of the strata.

"It is satisfactory to find that these conclusions are in perfect accordance with those to which geologists had arrived from other data. The details that lead to them will be described by M. Agassiz in a work of many

and will form a continuation of the Ossemens Fossiles of Cuvier. From the parts of this work already published, and from communications by the author, I select a few examples, illustrating the character of some of the most remarkable families of fossil fishes.

"It appears that the character of fossil fishes does not change insensibly from one formation to another, as in the case of many zoophytes and testaceæ; nor do the same genera, or even the same families, pervade successive series of great formations; but their changes take place abruptly, at certain definite points in the vertical succession of the strata, like the sudden changes that occur in fossil reptiles and mammalia. Not a single species of fossil fishes has yet been found that is common to any two great geological formations, or living in our present seas.

"One important geological result has already attended the researches of M. Agassiz, viz. that the age and place of several formations hitherto unexplained by any other character, have been made clear by a knowledge of the fossil fishes which they contain."

A very large space is devoted to the consideration of fossil shells and corals, and from this part of the work we extract the following passages on the "proofs of design in the mechanism of fossil chambered shells:"—

"I shall select from the family of multilocular, or chambered shells, the few examples which I shall introduce from mineral conchology, with a view of illustrating certain points that have relation to the objects of the present treatise.

"I select these, first, because they afford proofs of mechanical contrivances, more obviously adapted to a definite purpose, than can be found in shells of simpler character. Secondly, because the use of many of their parts can be explained, by reference to the economy and organization of the existing animals, most nearly allied to the extinct fossil genera and species with which we are concerned. And thirdly, because many of these chambered shells can be shown, not merely to have performed the office of ordinary shells as a defence for the body of their inhabitants; but also to have been hydraulic instruments of nice operation and delicate adjustment, constructed to act in subordination to those universal and unchanging laws which appear to have ever regulated the movement of fluids.

"The history of chambered shells illustrates also some of those phenomena of fossil conchology which relate to the limitation of species to particular geological formations; and affords striking proofs of the curious fact, that many genera, and even whole families, have been called into existence, and again totally annihilated, at various and successive periods, during the progress of the construction of the crust of our globe.

"The history of chambered shells tends further to throw light upon a point of importance in physiology, and shows that it is not always by a regular gradation from lower to higher degrees of organization that the progress of life has advanced, during the early epochs of which geology takes cognizance. We find that many of the more simple forms have maintained their primeval simplicity through all the varied changes the surface of the earth has undergone; whilst, in other cases, organizations of a higher order preceded many of the lower forms of animal life; some of the latter appearing, for the first time, after the total annihilation of many species and genera of a more complex character.

"The prodigious number, variety, and beauty of extinct chambered shells, which prevail throughout the transition and secondary strata, render it imperative that we should seek for evidence in living nature, of the character and habits of the creatures by which they were formed, and of the office they held in the ancient economy of the animal world. Such evidence we may expect to find in those inhabitants of the present sea, whose shells most nearly resemble the extinct fossils under consideration, namely, in the existing nautilus pompilius."

From the description of the important family of *ammonites*, we extract the following concluding passages, strongly recommending to our readers the perusal of the original work, in which this curious subject is well illustrated by a number of beautiful plates of some of the most important species:—

"On examining the proofs of contrivance and design that pervade the testaceous remains of the family of ammonites, we find, in every species, abundant evidence of minute and peculiar mechanism, adapting the shell to the double purpose of acting as a float, and of forming a protection to the body of its inhabitant.

"As the animal increased in bulk, and advanced along the outer chamber of the shell, the spaces left behind it were successively converted into air-chambers, simultaneously increasing the power of the float. This float, being regulated by a pipe passing through the whole series of the chambers, formed an hydraulic instrument of extraordinary delicacy, by which the animal could, at pleasure, control its ascent to the surface, or descent to the bottom of the sea.

"To creatures that sometimes floated, a thick and heavy shell would have been inapplicable; and as a thin shell, enclosing air, would be exposed to various and often intense degrees of pressure at the bottom, we find a series of provisions to afford resistance to such pressure, in the mechanical construction both of the external shell and of the internal transverse plates which formed the air-chambers. First, the shell is made up of a tube, coiled round itself, and externally convex. Secondly, it is fortified by a series of ribs and vaultings disposed in the form of arches and domes on the convex surface of this tube, and still further adding to its strength. Thirdly, the transverse plates that form the air-chambers, supply also a continuous succession of supports, extending their ramifications, with many mechanical advantages, beneath those portions of the shell which, being weakest, were most in need of them.

"If the existence of contrivance proves the exercise of mind; and if higher degrees of perfection in mechanism are proof of more exalted degrees of intellect in the Author from whom they proceeded; the beautiful examples which we find in the petrified remains of these chambered shells, afford evidence co-eval and co-extensive with the mountains wherein they are entombed, attesting the wisdom in which such exquisite contrivances originated, and setting forth the providence and care of the Creator, in regulating the structure of every creature of his hand."

One of the most remarkable, and till very lately, one of the most obscure, of all species of organic remains, is the singular fossil called the *trilobite*. This little fossil, the usual size of which does not exceed that of a walnut, claims our attention, not less from its singular form and character than from the circumstance of its being one of the earliest inhabitants of the globe, and one of those which became extinct at an exceedingly remote period, its remains being found only among the very ancient class of rocks, called *Transition*, giving it therefore a far higher antiquity than any of the organic remains which have yet been noticed. Although confined to so limited a portion of the geological series, and, as before noticed, of so small a size, the *trilobite* has disclosed to the penetrating research of modern philosophers, some of the most interesting and remarkable facts which are known respecting the economy of nature at the early period when this animal existed. These remarks apply chiefly to the late discoveries respecting the visual organs of the *trilobite*, a subject very fully and beautifully handled by Dr. Buckland, as the following passages will show:—

"Besides the above analogies between the trilobites and certain forms of living crustaceans, there remains a still more important point of resemblance in the structure of their eyes. This point deserves peculiar consideration, as it affords the most ancient, and almost the only example yet found in the fossil world, of the preservation of parts so delicate as the visual organs of animals that ceased to live many thousands, and perhaps millions, of years ago. We must regard these organs with feelings of no ordinary kind, when we recollect that we have before us the identical instruments of vision, through which the light of heaven was admitted to the sensorium of some of the first created inhabitants of our planet.

"The discovery of such instruments in so perfect a state of preservation, after having been buried for incalculable ages in the early strata of the transition formation, is one of the most marvellous facts yet disclosed by geological researches; and the structure of these eyes supplies an argument, of high importance in connecting together the extreme points of the animal creation. An identity of mechanical arrangements, adapted to the construction of an optical instrument, precisely similar to that which forms the eyes of existing insects and crustaceans, affords an example of agreement that seems utterly inexplicable without reference to the exercise of one and the same intelligent Creative power.

"Professor Müller and Mr. Straus have ably and amply illustrated the arrangements, by which the eyes of insects and crustaceans are adapted to produce distinct vision, through the medium of a number of minute facets, or lenses, placed at the extremity of an equal number of conical tubes, or microscopes; these amount sometimes, as in the butterfly, to the number of 35,000 facets in the two eyes, and in the dragon-fly to 14,000.

"It appears that in eyes constructed on this principle, the image will be more distinct in proportion as the cones in a given portion of the eye are more numerous and long; that, as compound eyes see only those objects which present themselves in the axes of the individual cones, the limit of their field of vision is greater or smaller as the exterior of the eye is more or less hemispherical.

"If we examine the eyes of trilobites with a view to their principles of construction, we find both in their form, and in the disposition of the facets, obvious examples of optical adaptation.

"In the asaphus caudatus, each eye contains at least 400 nearly spherical lenses fixed in separate compartments on the surface of the cornea. The form of the general cornea is peculiarly adapted to the uses of an animal destined to live at the bottom of the water: to look downwards was as much impossible as it was unnecessary to a creature living at the bottom; but for horizontal vision in every direction the contrivance is complete. The form of each eye is nearly that of the frustum of a cone, incomplete on that side only which is directly opposite to the corresponding side of the other eye, and in which, if facets were present, their chief range would be towards each other across the head, where no vision was required. The exterior of each eye, like a circular bastion, ranges nearly round three-fourths of a circle, each commanding so much of the horizon, that where the distinct vision of one eye ceases, that of the other eye begins, so that in the horizontal direction the combined range of both eyes was panoramic."

The subject of trilobites is concluded by the following passages, which afford an admirable display of that sound and philosophical reasoning, of which we have before given so many examples:—

"The results arising from these facts are not confined to animal physiology; they give information also regarding the condition of the ancient sea and ancient atmosphere, and the relations of both these media to light, at that remote period when the earliest marine animals were furnished with instruments of vision, in which the minute optical adaptations were the same that impart the perception of light to crustaceans now living at the bottom of the sea.

"With respect to the waters wherein the trilobites maintained their existence throughout the entire period of the transition formation, we conclude that they could not have been that imaginary turbid and compound chaotic fluid, from the precipitates of which some geologists have supposed the materials of the surface of the earth to be derived; because the structure of the eyes of these animals is such, that any kind of fluid in which they could have been efficient at the bottom, must have been pure and transparent enough to allow the passage of light to organs of vision, the nature of which is so fully disclosed by the state of perfection in which they are preserved.

"With regard to the atmosphere also we infer, that had it differed materially from its actual condition, it might have so far affected the rays of light, that a corresponding difference from the eyes of existing crustaceans would have been found in the organs on which the impressions of such rays were then received.

"Regarding light itself also, we learn, from the resemblance of these most ancient organizations to existing eyes, that the mutual relations of light to the eye, and of the eye to light, were the same at the time when crustaceans endowed with the faculty of vision were first placed at the bottom of the primeval seas, as at the present moment.

"Thus we find among the earliest organic remains, an optical instrument of most curious construction, adapted to produce vision of a peculiar kind, in the then existing representatives of one great class in the articulated division of the animal kingdom. We do not find this instrument passing onwards, as it were, through a series of experimental changes, from more simple into more complex forms; it was created at the very first, in the fulness of perfect adaptation to the uses and condition of the class of creatures, to which this kind of eye has ever been and is still appropriate.

"If we should discover a microscope or telescope in the hand of an Egyptian mummy, or beneath the ruins of Herculaneum, it would be impossible to deny that a knowledge of the principles of optics existed in the mind by which such an instrument had been contrived. The same inference follows, but with cumulative force, when we see nearly four hundred microscopic lenses set side by side, in the compound eye of a fossil trilobite; and the weight of the argument is multiplied a thousand fold, when we look to the infinite variety of adaptations by which similar instruments have been modified, through endless genera and species, from the long-lost trilobites of the transition strata, through the extinct crustaceans of the secondary and tertiary formations, and thence onwards throughout existing crustaceans, and the countless hosts of living insects.

"It appears impossible to resist the conclusions as to unity of design in a common author, which are thus attested by such cumulative evidence of creative intelligence and power; both as infinitely surpassing the most exalted faculties of the human mind, as the mechanisms of the natural world, when magnified by the highest microscopes, are found to transcend the most perfect productions of human art."

Proofs of Creative Wisdom and Intelligence, so perfect, so beautiful, and so conclusive, as are thus afforded by one of the earliest beings which inhabited the globe, can require no comment. They declare, in a language not to be misunderstood, that the same Infinite Power which rules over existing Nature, prevailed at periods infinitely remote, and that its earliest manifestations were contemporaneous with the dawn of animal existence.

(To be concluded in the following Supplement.)

The following letter from a correspondent we insert, without offering any remarks on the opinions or conclusions of the writer:—

TO THE EDITOR OF THE MINING JOURNAL.

SIR,—If Dr. Buckland would have the readers of his new work to believe, that those who "search the Scriptures" feel "disappointment" at not finding "a detailed account of geological phenomena in the Bible," his assumption is as "gratuitous" as he represents such "expectation;" and the same remark will apply to his assuming, that "those persons consider physical science a fit subject for revelation;" it is true they "search the Scriptures as for hid treasures," but not in "expectation" of finding an "electro-galvanic" lode, or imperfect representations of supposed animals or vegetables, but for the "pearl of great price."

There is, however, certain world-makers, who wish to find what is not "necessary," and who overlook that "which is able to make them wise unto salvation;" these are they who "impute imperfections of omission to the existing narrative of Moses," which, if considered done, will, of course, be a precedent for continued innovation on the sacred writings: but true believers feel convinced, as Dr. B. has expressed it, that "the design of all God's disclosures of himself has uniformly been, not to impart intellectual, but moral knowledge;" and as the silence of Moses and other sacred writers on the sciences does not argue imperfect knowledge thereof in them, the learned professor has begged the question to assume that the sacred historians must have given us (if any) the astronomy known to Copernicus," "the discoveries of Newton," or "La Place;" we must conclude they would have given us truth beyond the cavil of theory. In proof of this, no expression of theirs in connexion with the sciences go to prove the contrary. They never said the earth was *not* a sphere, or that it *was* a plane, or that the sun *was not* the centre of our system. And no doubt even "the chemical knowledge of the eighteenth century, together with the information of the present day," and much more (yet to be learnt by us) was known to Moses, who "was learned in all the wisdom of the Egyptians," "who were at that time the most intelligent and best instructed people in the universe;" in addition to which we was inspired by God for especial purposes, one of which we have now under consideration. And further, the conclusion is untenable, that Moses' "concern was barely to state, the matter of the universe is not eternal and self-existent," because all who believe in a great first cause think otherwise; and no materialist was, or ever can be, converted from his belief by what Moses has "barely" stated, independent of other causes, sufficient in themselves.

The learned professor plumes himself too because his "view of this subject is in perfect accordance with the highly valuable opinion of Dr. Chalmers;" but the quotation does not prove what the opinion of Dr. C. was, it is a string of questions, always easier made than answered; for example:—

Does Moses ever say that when God created the heavens and the earth *they were* produced from previously existing materials, and that *no more was done* at that time?

Does he ever say there *was* an interval between the first act of creation, described in the first verse of the book of Genesis, and those more detailed operations, the account of which commences at the second verse?

Or finally, does he ever make us to understand that the genealogies of man *do not* fix the antiquity of the globe as well as the antiquity of the species?

Passing over other matter, we arrive at the professor's crowing argument, extracted from Bakewell's "Introduction to Geology;" but, differing from him also, I would ask, have we not every proof that, in accordance with Gen. i. 28, not only land but aquatic animals are under great control of man? and that, for the most part, instead of "exulting in the pleasure of existence," fly the face of man with dread, on every approach; and as further proof of "human control" over the inferior creation, the rapidity of their increase would be beyond all calculation, and their aggregate number would be beyond all conception, independent of that control, supposing them to have existed for "no inconsiderable duration" before the creation of man, for "*by man sin* entered into the world, *and death by sin*:" it, therefore, follows, that as death did not exist before the fall of man, it could not have existed before his being created; how then are we to reconcile this theory of "organic remains" being deposited in any given stratum, before the introduction of death? which is a moral and not a necessary consequence; but Bakewell speaks of "lower orders of aquatic animals" only; but could these *die until the introduction of death*, and be "imbedded in the outer crust of our planet;" but if we stop here, whence comes organic remains, vegetable as well as animal, not aquatic.

But allowing the inferior creation is "independent of human control," does it follow they had an existence prior to man? and who dare say how far these are "subservient to the necessities of man?" Who can tell, for instance, the use of the hippopotamus? or even the ephemera? the rattlesnake or the musquito? yet "*in wisdom did he make them all.*"

It is nearly 4000 years since the deluge, and it is well known that local changes have taken place on our earth since that time, from "earthquakes, volcanoes, &c.;" and had it not been for more correct information, geology would have sent those changes to far more remote periods than those given by the history of the facts; and who can tell how the earth's surface was arranged previous to the deluge? where sea and where land (as to geographical situation)? and how natural to suppose that the motion of the waters removed elevated portions, burying organic matter beneath it, some at a greater and some at a less depth, when "infinite power so accelerated the properties of the secondary causes, temperature, atmosphere, moisture, dryness, &c., which He knew to be necessary to their formation, as to produce them at a time, and place, and season, in which human necessities required them."

"God said let there be light, and there was light;" could not the same being say, let there be coal-fields also? And "God created man, male and female created he them." Who doubts that the first human pair were perfect, as to stature, physical power, and mental capacity: could not the same being create coal of such a nature as we now see it as instantaneously as form a man, who we can prove requires numbers of years to attain perfect maturity?

GERMANICUS.

Oct. 31.

London and Edinburgh Philosophical Magazine and Journal of Science. No. 55, Nov. London: R. Taylor.

The number for the present month contains, in addition to several philosophical papers, the conclusion of Mr. Williamson's communication "on the Limestones found in the vicinity of Manchester;" which will be read by geologists with interest, as furnishing many interesting facts; and also an article by James Mitchell, Esq., LL. D., "on the Beds immediately above the Chalk in the Counties near London," which we have extracted at length in our present number. Mr. Hopkins's reply to Dr. Boase's remarks on Mr. Hopkins's "Researches in Physical Geology," is also concluded. The reply will meet with our earliest attention, as will Mr. Williamson's paper. Altogether the number may be considered as a fair specimen of the work, treating as it does, on a diversity of subjects. Were we to object to any portion of its contents, it would be to the publication, after an interval of six months, of the proceedings of scientific bodies, with abstracts of the papers read at their meetings. We are ready to admit the information afforded is interesting at all times, but it would be more particularly so, if given at an earlier period; and, anticipating in some degree the publicity afforded through other channels of communication, this remark, in making which we are not singular, will, we trust, have its desired effect.

The Railway Magazine, and Annals of Science. No. IX. By JOHN HERAPATH, Esq. Wild and Son, Charing-cross East, and Smith, Elder, and Co., Cornhill.

The number for this month contains an article "On Increasing the Gage of Railways, Heights of the Wheels, &c.," by the editor, and much useful railway intelligence. We have only space to direct observation to the abstract of a paper which appears in this week's journal, to show the value of a publication of this nature, when attention is directed to the object for which it is published.

Mechanics' Magazine. Part CLXV. Vol. xxvi. J. Cunningham, London.

This work considerably improves in the nature of the matter furnished through its columns, so far as subjects of natural philosophy, and those of science are connected; but we must protest against a work addressed to the mechanic and artisan, assuming a station which was never contemplated in its origin. We do not intend to convey an impression that the papers inserted in its pages will bear comparisons with those of the "Philosophical Magazine," and other similar publications; but if articles such as those to which we refer (many copied from works published in America), are to appear in the "Mechanics' Magazine," the sooner its title is changed the better, as it would not be then calculated, as it now is, to mislead.

Nearly one-fourth of the number is filled with Mackintosh's Lectures on his Electrical Theory of the Universe, and Colonel Maceroni's letters thereon. The Aurora Borealis has a notice of nearly five pages, extracted from the American "Journal of Science and Arts." The Eastern Counties Railway are favoured with eight columns of the report presented at the first general meeting, while other railway companies are passed unnoticed. This is a subject which should, we think, be left to the "Railway Magazine," a publication which purports to direct its attention to these matters solely. There can be no objection to communications on railways, or to the application of science, and the results of experience as regard its mechanical details, for these are fitting subjects for the pages of the work under notice, and should form at this moment some of its most important matter.

We have carefully perused the number before us, and regret to be compelled thus to advert to its advancement and retrograde movement at the same time; for while extracts from scientific works find place in the columns of the publication, the whole of the original matter comprehends but few articles, forming an insignificant portion of the work.

With the best feelings and wishes for the success of the "Mechanics' Magazine," as the medium of communicating information on subjects of mechanics, we would draw the attention of the editor to the change we have remarked upon, which, if continued, must have the effect of bringing a rival in that field, which he has heretofore made his own; for, although the "Mechanics' Magazine" may have a wide circulation as a scientific journal, the mechanic will find that a work more in accordance with its title and his wants is required.

One parting word, if the editor intends to render the work a mere compilation of extracts from other publications, it would be well to confine them to those subjects to which the "Mechanics' Magazine" should be directed, and not to abstruse sciences. We have only in conclusion to observe the number is good, we find not fault with the matter, but the absence of that species of intelligence for which we have been in the habit of looking in the pages of this publication.

Engineers' and Mechanics' Encyclopædia. By LUKE HEBERT. Part XIII. Kelly, Paternoster-row.

"How much useful knowledge is lost by the scattered forms in which it is ushered to the world! How many solitary students spend half their lives in making discoveries which had been perfected a century before their time, for want of a condensed exhibition of what is known."—BUFFON.

Such are the words which appear in the title-page of this work, of the truth of which we have daily evidence; and yet, although the truism is acknowledged, how few works like the present have we to boast of, as giving to the engineer and mechanic, as well as the general reader, a clear and "condensed exhibition of what is known" with reference to these important branches of our national resources and wealth.

Railways, that all *imposing* subject (in one sense too much so, as many will find to their cost), forms the most important feature in the present number, and is well illustrated by wood-cuts, explanatory of the remarks which appear, and the several extracts and reports embodied in the article. When we state that between eighty and ninety illustrations, with tabular matter, accompany the explanation, it will be readily seen, as we have before observed, that an extensive circulation can alone repay the expense incurred in the publication of the work, the price being comparatively insignificant, when the labour devoted to it is considered.

Pumps and quarries are also treated upon at some length, although we must confess that railways (because perhaps more popular) would appear to have entrenched upon the limits which should have been devoted to these subjects. We have not space to dilate on other articles treated on in the present number, but shall take an early opportunity of making a lengthened extract as an illustration of the utility of the publication.

ON THE BEDS IMMEDIATELY ABOVE THE CHALK IN THE COUNTIES NEAR LONDON.

BY JAMES MITCHELL, LL.D., F.G.S.

There is a description of flints found in beds immediately over the chalk, and below the sand, in all the places where these strata are seen to meet, in the counties of Surrey, Kent, Essex, and Hertford, and may very probably also be found in other counties, also in similar situations.

There are sixteen localities in which I have seen this flint on the south side of the Thames, and five on the north side.

The pits on the south side are:—

Pit close to Croydon in Coomb-lane.
Road to Tunbridge beyond Farnborough.
Pit on the right of the road from Bromley to Chiselhurst.
Pit in a vale on the south side of Elmstead near Chiselhurst.
Loam-pit near Lewisham.
Mouth of the cavern on the side of Blackheath-hill.
Pit in Old Charlton, on the south side of the Woolwich road.
Great pit at New Charlton.
Cliff opposite Woolwich dock-yard.
Pit at Erith.
Three pits near the bank of the river Cray near Crayford.
Pit on the north side of the churchyard at Dartford.
Trenches dug forming a common sewer near Gravesend, on property belonging to Mr. Rosier.
The entrance to the tunnel of the Thames and Medway canal at Higham.

On the north side of the Thames the localities observed are, Purfleet, a pit on the west side and another on the east side of Belmont Castle, near Grays, and a pit on the east side of Grays; also a pit at George's Farm, near Hertford.

A similar stratum is seen at Newhaven in Sussex, and the same flints have been seen in other counties, but not in their original site.

At Purfleet the name given to these flints is iron flints. The bed in which they are found is generally about eight or nine inches deep, seldom above a foot, and consists of a reddish clay, with an abundance of oxide of iron. Scarcely any sand can be got from this clay by washing. It is stuck quite full of flints. Some of these flints are very small, not exceeding an inch in length; but the greater portion are three or four inches long, and some much longer. They are round, and terminating in a point at each end, and on the whole in form not unlike a cucumber. Some, however, are of a triangular form. The exterior is covered with a rough black crust, which is found to be a combination of silex and oxide of iron. When broken by the hammer the oxide of iron is found to penetrate about a quarter of an inch all round, and there are frequently streaks of iron further in the interior. The body of the flint is black, but decidedly distinct from the dark blue flints found in chalk. The fracture is conchoidal, but these flints, though not unmanageable, do not yield flakes in any direction so readily as the chalk flints. When burnt in the fire, the exterior crust becomes reddish, and the rest of the flint is of a dirty white colour, not nearly so bright and beautiful as the porcelain substance made by burning chalk flints. It is exceedingly difficult, with ever so great caution, to get them burnt without cracking and flying in pieces. Such of these flints as have been exposed to the atmosphere have become partially decomposed immediately under the black crust.

I have been informed by two gun-flint makers that such flints afforded the best sort of gun-flints for gentlemen's fowling-pieces; but being less easily made than the gun-flints from the chalk flints, and the material being less abundant, they were more expensive. On account of the presence of so much iron, they are totally useless in the porcelain manufacture; but I have been informed that on one occasion as many as ten tons were obtained at the bottom of the great pit at Erith, which were so pure as to be saleable for that purpose. Few specimens are large enough for building, and, therefore, their chief use is for road-material.

An irregular broken line of flints of this description is to be seen at the sides of the deep cuttings at the entrance of the tunnel of the London and Birmingham railway beyond Watford. Great diluvial action has taken place, and the upper surface of the chalk is torn and ridged; and if, as we have no reason to disbelieve, there was a bed of sand here over the chalk, we must in consequence suppose that it has all been carried away. But the flints peculiar to such beds are seen above the solid chalk, and below the diluvial matter, scattered along on both sides of the cutting.

I have seen such flints in considerable quantity in the fields on the east side of Margate, in the Isle of Thanet, and likewise in Norfolk and Suffolk.

In the pit on the south side of Elmstead, near Chiselhurst, and in the pit on the south side of the Woolwich road, there are in the same beds with these flints innumerable small fragments of the same kind of flint, but not in the least rounded, and with sharp hedges; which proves that in these localities there had been agitations, and that the flints had readily been broken into fragments.

The most extensive section of this stratum which I have ever seen is at Newhaven in Sussex. It extends upwards of a mile along the top of the cliff, and the peculiar flints may be collected all along the foot of the cliff. They are well-known to the fishermen who collect chalk-flint boulders for the Staffordshire potteries, and are carefully avoided. One of these men said to me that he knew that one of them would be enough to spoil a hundred pounds' worth of good material. I found a cast of an Echinus there, but not a particle of the shell remained upon it.

There is another and very distinct variety of flint, which may be seen in some of the pits in the same bed in which the preceding variety has been found. I may mention the pit at Old Charlton, near the Woolwich road, in the trenches dug by Mr. Rosier, near Gravesend, and on the south side of Elmstead, near Chiselhurst; also at Purfleet.

These flints are very large, and of very irregular shape. They bear some resemblance to very large blocks of flint frequently seen towards the top of some chalk-pits. When broken with the hammer, however, they present instead of the deep dark-blue of the chalk flints a greyish surface, in many parts whitish, as if composed of silex differently granulated, and probably mixed with argillaceous or other matter. When burnt in the fire they appear still more decidedly different in appearance. There are streaks of oxide of iron diffused near the surface, and in many instances throughout the whole mass. The whole flint has not been formed at once, but one part has aggregated after another, and the divisions are very perceptible to the eye.

In the face of a fractured flint of this species is frequently seen one dark black piece surrounded with a mass of greyish flint, and sometimes more than one such dark piece. But sometimes also there is a greyish piece of flint surrounded by black flint; many divisions in curved and generally circular lines are perceptible.

When burnt in the fire these flints separate into pieces, leaving almost smooth surfaces on both sides at the places of separation. These flints are totally useless for gun-flints or for the porcelain manufacture, but are excellent for building.

Such flints are well known at Northfleet, being found very abundantly in the loam immediately over the chalk-pits near to Gravesend. But the watery action there has been so considerable that there is merely a thin stratum of diluvial matter and vegetable mould over the chalk; so that although I have known of them for several years past, it was not until a few months past I discovered them *in situ* in the places already stated. They are not unfrequently seen in the fields in the counties round London where the chalk comes up near to the surface. If a name be given to them it might be the grey iron flint.

In this flint I have found at Northfleet abundance of Echini, the *Echinocorys, Scutatus, Conulus,* and *Spatangus*, generally much crushed, and the shells themselves totally gone, probably corroded and destroyed by the oxide of iron.

Mr. Parkinson, in a paper published in the first volume of the Geological Transactions, has remarked the difference of the casts found in the gravel from the casts found in the chalk, and contends that they are of different origin. I have no doubt they are the same species as those in the chalk, and that this bed which I have attempted to describe is the original habitat of the fossils to which he refers.

The BEDS OF SAND immediately above these flints are of different kinds.

At New Charlton it is a fine white sharp sand, and is used in the foundries about London. The sand at Old Charlton is almost as good, but it is chiefly used for sanding floors. At Erith, Purfleet, and Grays, it is only fit for ballast. But in the trenches dug by Mr. Rosier, and at Elmstead, it is quite different. On taking samples of this sand to London, and washing it, and examining it when dry, I found it to be sand exactly the same as that which is well known near London as brickmakers' sand, which is exceeding soft when felt between the fingers, and is used for sprinkling the brickmakers' moulds to prevent the adhesion of the clay. It is obtained for that purpose from above the mud opposite to Woolwich, and off Crayford Point, and is, no doubt, washed down by the rain and brought into the Thames by the rivers Cray and Darent from the districts through which they run.

In respect to the chalk immediately below these beds of flint, in most of the localities examined the surface is perfectly level, even, and unbroken: and it is not furrowed and indented as some observers have represented the upper surface of chalk always to be.

That opinion must have been formed from the circumstance of the chalk, in almost all places where it is near the surface of the ground, having suffered much diluvial action; and from chalk-pits generally being opened, from a motive of saving expense, on the sides of hills, where there is little top surface to be carried off. In the pit at Elmstead it is, however, different from the other localities. There the chalk is cut into ridges, the hollows of which are filled with these flints and clays coloured with iron: which is a proof that in one instance at least the chalk may have suffered diluvial action before the formation of these flints and of the beds of sand over them; but being only one locality out of twenty-one, it shows that the general rule

MISCELLANEA

GERMAN RAILROAD.—It is a remarkable fact, that in the formation of the railway between Prague and Pilsen, the individuals employed were chiefly females, each of whose wages amounted to about 6d. a day. There were upwards of 2000 regularly engaged as labourers, in forming the embankments, excavating the soil, &c. During the two first years the engineer was able, in the course of 40 English miles, to cut no less than 696,465 cubic yards, and to construct 807,844 cubic yards of embankment, besides laying the way with malleable rails. He erected during these two years 73 bridges from three to eighteen yards each, with 133 culverts; and he also made 236 waggons. And all this at an expense of about 75,200*l.* sterling.—*Strang's Germany.*

COPPER SMOKE.—Attached to the New Copper Works, belonging to Messrs. Vigors and Co., in Cwm Avon, is a tunnel for consuming and conveying copper smoke, one thousand one hundred yards in length: viz. from the smelting furnaces to the top of the high hill towards the north west, called Môl-y-Mynyddau. In this elevated spot the small quantity, if any, that will escape precipitation, will find its way into the air. Few persons probably are aware of the immense quantity of copper thus saved to the proprietor, which, in former times, was deposited on the neighbouring lands, subjecting him to most expensive actions. In a tunnel not long made by Messrs. Williams and Co., in their works on the Swansea river, two hundred tons of copper were taken out, which had been precipitated in the short space of one year—the value of this was 2000*l.*, and much was still left in the tunnel. Chambers are made in the tunnel for attracting the smoke, which is further promoted by the use of steam, so that little of it is allowed to reach the place of exit, till it has deposited, *in transitu*, all its substance. This material, therefore, which not only was formerly lost, but did serious mischief to the adjoining lands, thereby entailing lawsuits of ruinous expense, becomes now a matter of important profit.—*Merthyr Guardian.*

NAVIGATION OF THE SHANNON.—We rejoice to see it stated in the newspapers, that Government has granted 40,000*l.* towards the improvement of the river Shannon. We last year descended this magnificent stream, and were amazed at the capabilities it offered for the improvement of all those rich tracts of country through which it rolls its waters, and for promoting the general wealth and prosperity of Ireland. Such an artery ought, alone, to convey the life-blood of industry, activity, commerce, and riches, throughout a whole nation, and its collateral veins be amply sufficient to circulate comfort and happiness among a people as numerous as the inhabitants of Ireland.—*Literary Gazette.*

BELGIAN SCHOOLS OF ART.—In the Sunday Schools at Antwerp, the children of the poor are instructed to the number of from 7000 to 8000, and the instruction given is not only in reading and writing, but also in design. Since the institution of these schools, the intelligence of the people generally has been greatly developed in reference to the arts. The children who show a disposition for the arts are encouraged to pursue it; a vast number of painters in Antwerp have risen from the lowest classes of society. The next step in popular education is taken in the academies where the fine arts are taught; the workmen generally frequent the academies, which are open to every person. The great change in the taste of the people dates from the last re-organization of the general system of instruction, about 16 years since. The manufactures of Belgium have also improved, as well as the national taste, within that period.

EARTHQUAKE.—About midnight, on the 15th ult., a slight shock of an earthquake was felt at Rawcliffe-bridge, and at the farm-houses contiguous to the Dutch River, attended with a rumbling noise somewhat like the rattle of a heavy carriage, which lasted a few seconds, and greatly alarmed many of the inhabitants. It caused the furniture in some of the houses to shake about considerably, and varied in its effects in different houses, but was pretty generally felt; whilst some experienced it quite distinctly, others just discerned a motion and heard a noise. It was more felt at Rawcliffe-bridge than at the village of Rawcliffe.—*Doncaster Gaz.*

IMPORTANT DISCOVERY.—Providence seems to have especially favoured one particular district in the vicinity of Galway, by furnishing on it, independent of the black marble quarries (now extensively worked) the most abundant supply of superior materials for the manufacture of glass, alum, and superfine pottery. The sand is of the sandstone quality, nearly white, and the earth was discovered unexpectedly in a pit or excavation made on a hill to the depth of twenty-five feet, all of the same solid substance, but varying in colour, and becoming almost black and hard towards the bottom, at which geologists will be surprised and puzzled to hear, an oak tree lay buried, which had been evidently felled with an axe. What the underneath strata may be has not yet been investigated.—*Galway Patriot.*

FATAL ACCIDENT.—A melancholy accident occurred on the railway constructed for the purpose of conveying stones from Craigleith Quarry to Granton Pier. A young man, of the name of Anderson, who had the charge of a train of waggons, each heavily loaded, while in the act of putting a drag upon the wheel of the waggon in front, to prevent it coming in contact with the horse dragging the train on an inclined part of the road, was thrown down by a fore wheel and fell in front of the waggon, when, melancholy to relate, the whole of them passed over the middle of the unfortunate man, literally cutting him asunder.

A NEW CONSTRUCTION OF RAILWAYS.—Mr. Perkins has just exhibited a new plan of railways, which he has secured by patent, and which from the explanation given by him, would appear calculated to supply the desideratum so long desired, and indeed appears to form an era in the progress of those great national undertakings towards perfection. The plan embraces two modes of construction, founded on one common principle, viz. the continuous support of the rails. In the one case this is effected by blocks of vitrified earth, as hard and durable as granite, and which lock into one another, being laid on a concrete foundation; and in the other, by an additional depth of concrete supplying the place of sleepers altogether. Upon the former plan, wooden bearers, four inches in the base, four thick, and two wide, on the top, rest upon the vitrified blocks; and in the latter, upon the concrete, to which they are firmly secured. In both cases iron bars, with the means afforded for expansion and contraction, are fixed on the wooden beams, and the foundation being continuous and solid, in fact like one block of granite the whole length of the road, no vibration is felt, as the numerous persons who rode in the waggon unanimously testified; and this is an important attainment in railway constructions. The saving by the plan first described will, it is stated, be full 4000*l.* per mile, in four rows; and by the latter, very much more—in fact, so enormous will it be, as to give a new feature to railways, and astonishingly facilitate their construction in all parts of the country. We should much like to see it in practice, which is alone the test: so fallacious are frequently found to be the results when based alone on novelty and experiments.

AMERICAN SPECULATIONS.—The rage for the formation of banking and other companies and railroads, appears still to prevail in America quite as much as it did in the early part of the year, and the objects seem to be occasionally as incongruous. Thus, in one scheme is combined banking and the making of sugar from beet-root. The notice sets forth that "application will be made to the legislature of this State (New Jersey) at their next session to incorporate a company for the purpose of manufacturing sugar from beet, to be located in Bergen, Essex, &c. Capital 500,000 dollars, with banking and trust powers." There also appear notices regarding similar applications for a railroad from Paterson to Hackensack, to connect with a railroad leading from Hoboken to Hackensack; for the East Brunswick and Raritan Manufacturers' Bank, capital 300,000 dollars, with liberty to increase it to 500,000 dollars; for a Spottswood Bank; for a railroad from New Jersey Railroad to New Brunswick to Bound Brook, with the privilege of extending it.—*Times.*

SPEED.—Mr. Horace Smith, in a lecture delivered at Brighton, on the powers of steam, and the future prospects it opens to the world, mentions a projector, whose enthusiasm carried him so far, that he prognosticated the time would shortly arrive, when by steam and railroad, "a man might travel from Brighton to London in less time than he could stay at home!" Of course it must be by the line without a tunnel.—*Literary Gazette.*

FOSSIL TABLE.—Mr. Harvey, of Teignmouth, an active corresponding member of the Zoological Society, and a valuable contributor to its conchological stores, has just had completed a table-top of three feet four inches in diameter, composed entirely of madrepores, selected by that gentleman from the limestone with which the neighbourhood abounds. The beauty of the specimens, which it has been the labour of years to collect, the variety of their colours, and the taste in their display, renders it as a curiosity *unique*, and it is about to be sent up to London for exhibition in the museum of the Zoological Society.

IRON TRADE.—The iron-masters' quarterly meeting in this town was held on Thursday week, and was numerously attended. A good deal of business was transacted, but we understand that no rise in prices took place. Thus far the *Birmingham Gazette*.—And now, what says the *Birmingham Advertiser*—"At the iron-masters' quarterly meeting in Birmingham, on Thursday week, a good deal of business was transacted, but no alteration in prices took place, although Wales had reduced the price of iron 10s. per ton four or five weeks ago." But we learn from Scotland that the price of pig iron has fallen 20s. per ton, and we have no doubt but that purchasers will find a similar reduction in South Wales, although no specific announcement of the *ferruginous swine's* downward course may have been made.—*Brecon Gazette.*

STEAM-ENGINES IN BELGIUM, AND COMPARISON WITH THE NUMBER EMPLOYED IN FRANCE.—There are at this moment in activity in the Province of Liege, 216 steam-engines, exerting altogether 5445 horses' power. Of these 216 engines, 139 are on the right bank of the Meuse, exerting equal to 2176 horse-power; and on the left bank 79, or 3269 horse-power. Of the whole of these engines, three only are of foreign manufacture. The largest engine is of 300 horse-power; 20 from 50 to 10; 38 from 20 to 50; 139 from 5 to 20; and 1 of 1½. If we join to the motive-power of the steam-engines of Liege that of the engines in other Belgian provinces, a total would be formed of about 20,000 horse-power. It is principally in Hainault, about Charleroi, and in Borinage, that the largest engines are found. According to the reports published by the *Administration des Ponts et Chaussées*, in France, there are 946 engines, representing not more than about 14,051 horse-power. Belgium thus surpasses by about a third the power of all the steam-engines in France. Upon this foundation, therefore, and comparing the respective population of the two countries, we find that Belgian industry is twelve times more developed than French!—*Recueil Industriel.*

AUSTRALIA.—Official returns of the imports and exports for the past two years:—

	Imports.	Exports.
1835.....	£383,646	£320,679
1834.....	476,617	203,522
Increase	107,029	117,157
		Tonnage.
1835.... Vessels cleared outwards....	169....	43,476
1834.... Ditto ditto	150....	33,441
Increase.....	19	10,035
1835.... Vessels entered inwards	160....	42,001
1834.... Ditto ditto	134....	29,588
Increase.....	26	22,413

ENORMOUS MASS OF MALACHITE.—In June, 1835, a mass of malachite was discovered in the mines of P. and A. Demidoff, at Nischnei-Tagilsk, in the district of Jekaterinburg, measuring 16,2 feet (French measure) in length, 7,6 in width, and 8,6 in height; it weighs, therefore, by admeasurement, 350 ponds of Russia, each pond being equal to rather more than 16 kilogrammes French weight: making this enormous mass upwards of five tons and a half English weight. No cracks or imperfections had been discovered so far as the examination had then been made. The largest block of malachite previously discovered in Russia weighed ninety pounds: it was discovered in the mines of Furchaminoff, and is now deposited in the museum of the corps of miners, at St. Petersburgh.—*Naturalist, No.* 3.

ANOTHER LOCOMOTIVE ENGINE FOR RUSSIA.—On the 15th of September, a large and powerful locomotive-engine, built by Mr. Timothy Hackworth, of New Shildon, for the Emperor of Russia, was shipped on board the *Barbara*, at Middlesbro'. This engine is constructed on an improved principle, and finished in the best manner. She has been tried on the premises, and propelled at the rate of seventy-two miles per hour. It is said that this machine, and the similar one built at Newcastle, will, on their arrival at St. Petersburgh, have cost the Emperor upwards of 2000*l.* each. Who, a few years ago, would have dreamed of the exportation of machinery from the river Tees? This engine is for travelling on the railroad from St. Petersburgh to Powlosky, where stands one of the country palaces of his Imperial Majesty.—*Mechanics' Magazine.*

RAILWAY PERFORMANCE EXTRAORDINARY.—The locomotive steam-engine George Washington, made for the state of Pennsylvania, by William Norris, of Philadelphia, was placed on the Columbia and Philadelphia railroad on Saturday afternoon, the 9th ult. On the following morning her powers were tested in ascending the inclined plane near Philadelphia. This plane is 2800 feet in length, with an ascent in that distance of 196 feet, or at the rate of 369 feet to the mile, or seven feet rise in 100 feet, or one foot in thirteen. The weight of the engine is 14,930lbs. only. The load attached weighed 19,200lbs., including the weight of 24 persons who were on the tender and burthen car. The engine started immediately at the base without a running start, and dragged up the said load of 19,200lbs. the above distance of 2800 feet in the space of two minutes and one second, or at the rate of 14 2-3rd miles per hour; pressure on the boiler a fraction under 60lbs. to the square inch. The engine then descended the plane with the same load at various speed, frequently stopping to test the security. The valves being reversed, or set for going a-head, and when it was desired to stop altogether, the steam was let on very slowly, which brought her to a dead stand for a second or two, when she would immediately start up the grade. In this way, stopping and starting at pleasure, the time occupied in descending the 2800 feet was from twelve to fifteen minutes, thus testing the perfect security of her performance on the plane. She again ascended the plane with the same load, and took her place on the road, the same morning, ready for use.—*American Railroad Journal.*

SUBMARINE ILLUMINATION BY THE DRUMMOND LIGHT.—We find by the Irish newspapers, that Mr. Steele, who has devoted himself with so much ardour to the subject of submarine operations, and who is the inventor of the communicating diving-bell, has lately made a very important improvement in this department of physical science. This improvement consists in the substitution for the light which he originally proposed for the irradiation of objects under water, of what he calls "the piercing ray of the Drummond light in its gorgeous glory." He has consulted several highly distinguished engineers of this metropolis, and they have been unanimous in their opinion, that this new application of the Drummond light is an improvement of the greatest importance, and it is impossible that any thing can be more simple than the mode proposed by Mr. Steele for its application to his purpose. It appears from the Irish newspapers that this improvement in his theory was made by him while observing Mr. Deane's operations at Kilkee, on the coast of the county Clare. We have seen several of Mr. Steele's publications on this subject in the journals of our Irish contemporaries, and he writes in terms of measureless admiration of the infinite beauty and perfection of Mr. Deane's system of rapid diving. Among the London engineers who have expressed the highest approbation of Mr. Steele's new theory of submarine irradiation by the Drummond light, is, we understand, Mr. Alexander Gordon, who has particularly applied himself to the subject, and lately obtained a patent for a very beautiful mode of generating and applying the oxy-hydrogen gas.—*Sun.*

FIRE-DAMP.—On Wednesday se'nnight, about four o'clock, when the colliers belonging to Mr. Wilson's works, at Dalmarnock, went down to their employment, they found two Irishmen, who had gone down the preceding evening to clear the roads, lying dreadfully mangled and quite dead. There is little doubt the accident was occasioned by the fire-damp coming in contact with their lamps. They were both married men.

MEASURING THE HEIGHT OF MOUNTAINS.—Professor Carus, of Dresden, has proposed a plan of ascertaining the altitude of mountains by the senses, instead of barometrical admeasurement. He founds his calculations upon the well-known fact, that a peculiar sensation is produced in the ear, when we rise above a certain level; and conceives that the analogy between the air bladder in the fish, and the auditory organ in a man, may serve as a measure of the pressure of the air. The present rage for aerostation in this country, might, perhaps, be turned to some account in verifying or confuting the views of the learned professor.

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